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Paper Session I-D - Development of a Low-Cost Elementary School Computer Lab Using Excess NASA Equipment

Daniel Woodard

The Bionetics Corporation, Mail Code BIO-1, Kennedy Space Center, FL 32899

A Low-Cost Elementary School Computer Lab Using Surplus NASA Equipment

Daniel Woodard
The Bionetics Corporation, Mail Code BIO-1, Kennedy Space Center, FL 32899
woodardd@lahal.ksc.nasa.gov

Background

This project was initiated as a result of an address by NASA Administrator Dan Goldin at KSC in 1995, in which he advised KSC employees to become involved in education as a critical goal for the future. In my work as an emergency physician I come in constant contact with children and teenagers in Florida, and have observed that a growing percentage have difficulty with simple verbal communication and lack the basic skills required to achieve success in technologically demanding careers. This is most commonly a problem with children from poor backgrounds; a growing percentage are permanently disenfranchised from our vision of the future and are likely to become a costly and destabalizing factor in future society.

What can be done? Resources are obviously limited; as Florida consistently ranks among the lowest of the 50 states in suport for public education, and alternatives such as private and charter schools will never be available to the majority of children at risk. Moreover, there is little evidence computers provide a meaningful benefit even in districts with adequate resources:

“Schools in the United States have 5.8 million computers for use in instruction—about one for every nine students. ... Despite technologies available in schools, a substantial number of teachers report little or no use of computers for instruction. Their use of other technologies also varies considerably.” (From Now On, http://otabbs.ota.gov/T128/)

Distribution and Utilization of Computers in the Classroom

A major problem in Brevard County is that virtually all classrooms that have computers have only one or a few. As a result they can only be utilized by a handful of students at a time, and only when the class is doing small group activities. A number of teachers and school administrattors have stated that their classes are organized to spend the majority of their time in such activities, but no evidence to substantiate this is available. Discussion with students indicates the exact opposite, that most of the class day is always spent in full-class activities. The computers obviously cannot be utilized when all the students are performing the same task, and are severely underutilized; even in the Gifted Student Program each computer is used only about 1 hour/day.

Even when the computers are in use, generally several students are assigned to share a computer as a group, an approach which benefits the most aggressive students and and those most familiar with computers already, and leaves behind those who need help the most. The students at risk of failure will benefit only if every student in the class has access to a computer, and this will only occur if the room has a computer for every student.

Objectives of Computer Use in Elementary Education

Computers are generally marketed at educational trade shows as a sort of mechanical teacher, with multimedia programs designed to entertain as well as provide facts for the student. This encourages the use of systems with color and CD-ROM, costing at least $1500 per unit for hardware alone, and often an equal amount for software, making the goal of a computer for every student utterly impossible in Brevard County. The value of such software is unproven, but even excellent programs of this type, such as “Reader Rabbit” version 1, can be completed by the average student in a few hours, and therefore can’t fill more than a tiny fraction of the cirriculum.

Some schools emphsize using the computer as a reference tool, either with CD-ROM databases or by “surfing the net”. In practice this is very time consuming; for the most part the elementary cirriculum can and must be organized in advance to cover the required subjects adequately in class. Similarly, instruction in computer programming and discussions about how computers work are relevant to students who will actually work in computer science and technlogy, but to most students they are no more important than knowing how a ball point pen works, or the composition of ink.

In contrast, almost everyone uses a computer to create and organize ideas, and to communicate in the written English language. In this role the computer serves not as a mechanical teacher or an encyclopdia but rather as a logical descendant of the clay tablet, papyrus, the pencil and paper or typewriter. It has largely supplanted these other forms of written communication because it is faster and more efficient, not just for professionals but also for students at every level.

Hardware and software selection

Use of the computer as a tool required a system that allows an 8-year-old who has never used a computer to turn it on, start the appropriate program, and compose and print an original document with only a few minutes instruction. It does not require color, multimedia, extensive software, or internet access. Such capabilities are appropriate for some students, at the high school level, who are learning to create multimedia publications and software, but for elementary students they can actually be a disadvantge since they distract from the importance of written language and make the student’s own creative work seem trivial by comparison.

The computers selected were Mac Plus’s and Mac SEs obtained through the Stevenson-Hawley Program from excess at Kennedy Space Center. The only software utilized was Claris Works 2.1 (only the word processor capability was used) and Type to Learn, a program which teaches touch typing. These two pieces of software can be used indefinitely without ever reaching a point where they are no longer challanging.

Initially school administrators were discouraged by the number and condition of computers that were obtained fron excess. All the computers required software changes and approximately half required repairs or cannibalization of parts. It required approximately one year to apply for the program and accumulate enough computers for a comlete class.

School administrators and some teachers were also very skeptical that a computer which has only a nine inch screen with no color or even gray scale capability would interest the students or be educationally useful. In fact, the intuitive nature and ease of use allowed the students to begin

using the computer within about 10 minutes of beginning the first class, and virtually every student was focussed on his or her work for every class.

There was also doubt that only two pieces of software would be sufficient for teaching anything more than “word processing.” In fact, a a result of the ease of use and intuitive interface of the computers used the students for the most part learned at least the basics of “word processing” withing the first few minutes. Encouraged to use the computer to organize and express their ideas and creativity rather than simply absorb information, never approached the limits of the simple software provided.

The Mac SEs and two Apple Laserwriters were connected by appletalk phone-net with standard phone wire. Operating System 6.0.8 was utilized for the Mac Plus, SE, and Classic computers, all of which were equipped with 2 Meg of RAM. Two SE/30s were included in the network as file servers using System 7.1 and 4 Meg of RAM. More recent versions of the operating system and software would have required additional memory and provided no useful benefit. Apple Computer is still aggressively pursuing the education market; unfortunately they have not indicated interest in producing a computer that would cost less than about $700.

Figure 1. Second Graders are decidedly not bored with the simple Mac SE.

Facility Layout

To accomplish the goal of providing a computer for every student it was decided to group all the computers in a single room and bring complete classes in for periods of approximately one hour. An existing conference room was utilized, with the computers arranged around the perimeter of

the room against the wall. Safety regulations prohibit permanent installation of “extension cords” or outlet splitters, and most classrooms don’t have enough wall sockets for every computer. The use of a single surge suppressor equipped with a circuit breaker is permitted, however, and there is no specific limit on the length of the line cord or number of outlets on the surge suppressor power strip. Placing the computers around the periphery of the room permits a safe installation with no permanent room modifications. Also, as shown in the illustration, the teacher can easily assist any student by looking over his/her shoulder at the screen.

Figure 2. An existing multipurpose room accomodates a full class and can still be used for other functions. Every computer is in use most of the day, and while the class is in the lab every student has access to a computer. The teacher can instruct the full class simultaneously.

Teacher Orientation and Teaching Methods

The six teachers interested in using the facility initially were provided with a brief orientation on use of the computers, software, and printers. The author was present during initial classes to resolve problems. Teachers instructed the students how to start Claris Works and begin a document, how to save files, and how to print. This requirted roughly 20 minutes for the class. The students then began typing from rough drafts prepared on paper. The author suggested but was not able to persuade them to begin the document on the computer alone. When a student encountered a problem he/she would raise his/her hand, and the teacher could assist the student individualy. The teachers were encouraged to begin with at least an hour of keyboarding practice, but school district policy requiring each student complete a computer generated document before the end of the school year forced the teachers to start students typing documents immediately. There was some difficulty printing as all attempted to use the printers at the same time during the last few minutes of their classs period.

Figure 3. The teacher can walk directly to and assist any student individually without disturbing others.

Student feedback

For virtually all students, even those who had home computers (about 25%) this was the first time they had used the computer to create something of their own. There was difficulty printing (all attempted to use the primeters at the same time during the last few minutes of their classs period). None of the students reported ever being bored when they were actually using the computers. We also learned that if the computers were not essentially identical in appearance and capability there would be conflicts between the students over which one they would use, and some would be consistently short-changed.

Utilization

As soon as the facility was operational teachers were free to reserve the computer lab for blocks of time. On average during the last month of the 1965-66 school year all the computers were in actual use for four hours per day, resulting in an average utilization of about 100 student hours per day, 67% of the theoretical maximum.

Cost

Although most of the computers were obtained free of charge by NASA and other businesses and individuals, three were purchased used and a variety or parts and repairs were obtained commercially, at a total cost of $1200, provided by the Parent Teacher Organization. Approximately 200 hours of work was also required by the author and other volunteers, including setup, repairs, and screening surplus supplies.

Staffing Strategy

Two basic appraoches are possible, as with any subjet: the class can be taught by its regular teacher (as are writing, arithmetic, etc,) or by a different teacher who usually teaches only one subject to many classes, as are physical education, music, and art.

In its initial year each class was taught in the computer lab by its regular teacher, with the occasional assistance of a person who was technically experienced but not a certified teacher (the author). In the second year a teacher was hired to provide all instruction on the computers. This was not strictly a policy decision. The school lost a physical education teacher and the requirements placed on the school administration by funding limits and teacher contracts meannt that the regular classroom teachers could be provided with requred non-class planning time only if another special subject teacher was added, paid for by funds available only for special purpose teaching.

The first appraoch had the disadvantage that many of the primary teachers didn't feel sufficiently experienced and trained to teach a class using computers, although a sufficient number were interested to fully utilize the facility. The current approach allows all classes to use the facility equally. However there are major disadvantages: The computer eduation teacher, although well versed in the theoretical aspects of compute education, had no experience or interest in maintaining computer hardware and required considerable technical support from the school district (paid for out of the school budget) to do so. Perhaps more important, lack of exposure of primary teachers to the computers makes it impossible to integrate computers into the everyday cirriculum as a tool for communication, and perpetuates their separate status. There is no way for the school to provide more access to the computers than a single classroom shared by all the classes.

An alternative approach, used by some schools in Brevard County, is to hire a full or part-time techincal person (which can be done at lower cost and from a different funding source than a teacher). This technical support person instructs the teachers in operation and use of the computers and physically maintains the hardware, software, network, etc. Local costs are increased but technical support within the school is faster than getting such support from the district, with less administrative costs, and as the school accumulates more computer equipment additional classrooms can be set up. Most importent, the primary teachers become familiar with computers and are encouraged to integrate them into the primary curriculum.

Simply for a school to make a reasonable decision about this issue, the taxpayers must provide sufficient funding to allow the administration some flexibility in staffing, and sufficient parental involvement to provide a share of the essential techincal support.

Conclusion

This project demonstrated development and implementation of a computer instruction facility at a cost of less than $50 per computer, achieving a utilizaton of 100 student hours per day. Critical choices include a clear understanding of the role of the computer in elementary education, an optimal approach to teacher staffing, and a strategy for future growth. Students learn more effectively by using the computer as a tool to create rather than as a source of facts. Color, sound, and elaborate software are far less important than ease of use and access. It is essential to provide a computer for every student in a class, and ultimately for every student in every school; anything less will leave behind the very students we need most to bring with us into the future.